Concept of Thermal Sheet and its Design for Sustainable Heating and Cooling Using Thermodynamics and Heat Transfer

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Abstract— *The present disclosure relates to an apparatus that can maintain a required thermal condition[TC] of an object for a period of time. The apparatus comprises a thermal sheet[TS] having thickness[t] nearly same as a blanket and incorporates a pipe to circulate a fluid. The thermal sheet can be used in combination with a Thermal Energy Reservoir [TER] that can be configured with a thermally insulated chamber to hold a thermal reservoir substance kept in the thermally insulated chamber. A pump can circulate the fluid through a second pipe placed in the thermally insulated chamber and thereafter through the pipe in the thermal sheet. A hot reservoir substance [heat source] can provide heating effects and a cold reservoir substance [heat sink] can likewise be used to provide a cooling effect. Thus the thermal sheet[TS] has the capability to keep a body at a required thermal condition[TC] (high or low temperature) for a period of time.*

Keywords— Heat Source, Heat Sink, Sheet Thickness[t], Thermal condition[TC], Thermal sheet[TS], Thermal Energy Reservoir[TER].

I. INTRODUCTION

It is usual for people to keep themselves and/or other objects protected or comfortable from extremes of temperature by various means. The need is especially more pressing for those having physical infirmities such as sick, old or infants and in factories/workshops where attaining and/or maintaining thermal conditions is very vital. Accordingly during extreme low temperature conditions stoves, electric heaters, and other warm-keeping apparatus are used for the sick persons, the children, the old persons etc. or even by able bodied persons and to keep machinery/equipment at a desired thermal condition. Likewise during hot conditions air conditioning is used. While use of devices like stoves that depend on direct burning of fuel are harmful on account of harmful gases, devices, both cooling as well as heating, that depend on electricity are expensive and costly to operate. They are also harmful for environment due to consumption of disproportionately large amount of energy. Besides such devices though quite effective are not likely to be available outdoor or in remote locations. It would, therefore, be advisable to reduce our dependence on air conditioners and heaters to the extent possible by substituting them with some suitable device wherever possible. Heating blanket/pad/bed spread are some such devices commonly used during extreme cold temperature conditions. There is however no such device that can be used during hot/high temperature conditions. It would, therefore, be advantageous if a sheet like device that can be used during both high and low temperature conditions, is made available. Such a device can reduce our dependence on heaters and air conditioners, reduce energy consumption and at the same time shall be available for use in outdoor and remote locations.

II. OBJECTS OF THE SYSTEM

An object of the present disclosure is to provide an apparatus that can be used for both heating and cooling applications to reduce dependence on heaters and air conditioners. Another object of the present disclosure is to provide an apparatus that can be used for both heating and cooling applications with minimum changes.

Another object of the present disclosure is to provide an apparatus that consumes very less amount of external energy. Another object of the present disclosure is to provide an apparatus that has capability to keep a surface/body at a required thermal condition (high or low temperature) over a period of time.

Another object of the present disclosure is to provide an apparatus that can be manufactured in different sizes and shapes, thereby making it versatile in application.

In an embodiment, the same sheet can be used both for heating and cooling applications. In an aspect the disclosed thermal sheet can be used in combination with a

Thermal Energy Reservoir (TER) that can be configured with a thermally insulated chamber to hold a thermal reservoir substance kept in the thermally insulated chamber. A hot reservoir substance (heat source) can provide heating effects and a cold reservoir substance (heat sink) can likewise be used to provide a cooling effect.

In an embodiment, the disclosed thermal sheet can be configured so that it can be connected to different T.E.R. boxes for different applications such as heating application or a cooling application. Likewise, different thermal sheets can be connected to a T.E.R. box. The connecting pipes can be of any length and flexibility depending on the necessity.

In an embodiment, heat transfer between the thermal sheet and hot/cold reservoir substance can take place through a fluid circulating in a pipe/pipes placed in the Thermal Energy Reservoir and the thermal sheet.

In an embodiment, the T.E.R. box can further comprise a pump to facilitate circulation of the fluid through the Thermal Energy Reservoir and the thermal sheet.

III. FIGURES

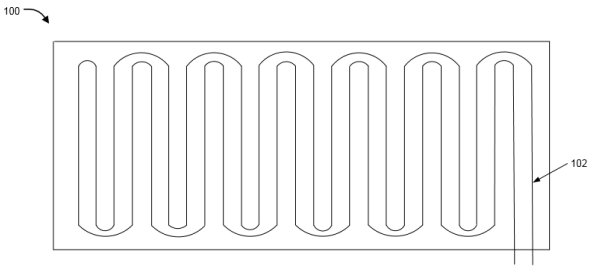

Fig. 1: Schematic diagram of Thermal Sheet

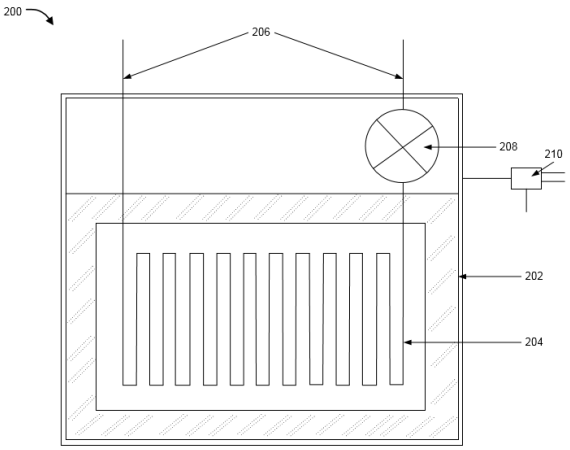

Fig. 2: Schematic diagram of TER Box

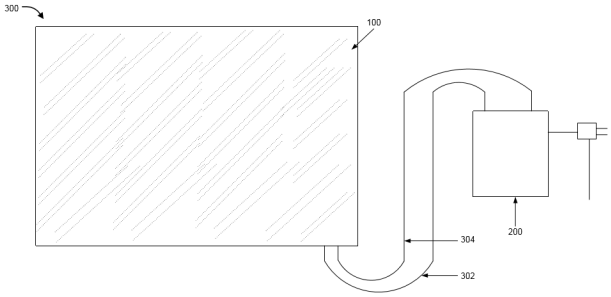

Fig. 1: Thermal Sheet - TER Box assembly

IV. BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an exemplary schematic diagram of the thermal sheet in accordance with an embodiment of the present disclosure.

FIG. 2 illustrates an exemplary schematic diagram of the thermal energy reservoir incorporating a pump assembly in accordance with an embodiment of the present disclosure.

FIG. 3 illustrates an exemplary schematic diagram of the thermal sheet along with the thermal energy reservoir in accordance with an embodiment of the present disclosure.

V. DETAILED DESCRIPTIONS

Embodiments of present disclosure relate to a thermal sheet that has capability to keep a surface/body at a required thermal condition (high or low temperature) for a period of time. In an aspect the disclosed thermal sheet maintains the desired temperature by drawing heat from a source or dumping heat in a sink depending on the operating requirement.

In an embodiment, the medium that works as a heat source or as a sink can be stored in a thermal energy reservoir. The thermal energy reservoir can be thermally insulated to conserve the stored heat/maintain low temperature of the heat source/heat sink.

In an embodiment, heat transfer between the thermal sheet and hot/cold reservoir substance can take place through a fluid circulating in a pipe placed in the Thermal Energy Reservoir and the thermal sheet.

In an embodiment, a pump can facilitate circulation of the fluid through the pipe placed in the Thermal Energy Reservoir and the thermal sheet. In an aspect the pump can be electricity driven and require very low external energy to maintain the desired condition (hot/cold) of the thermal sheet.

Referring now to FIG. 1 wherein an exemplary thermal sheet 100 in accordance with embodiments of the present disclosure is illustrated. The sheet can be made of a suitable material such as but not limited to foam and fiber composite material with a pipe 102 placed within the thermal sheet 100 in a pattern such as parallel pattern with

both ends of the pipe 102 slightly extending out of the sheet 100. The size of the sheet 100 can vary depending on the required end use. The foam and fiber composite material can provide a good cushion, trap air in the pores and provide some protection to the pipe 102. In an embodiment, one side of the sheet 100 can be configured to be thermally insulating to prevent heat transfer and maintain the temperature of the object covered by the sheet 100 and other side i.e. the side facing the object, can be thermally conducting to enable quick and efficient heat transfer from the object to the medium within the pipe 102. The pipe 102 can be of a thin bore pipe with optimized dimensions for maximum heat exchange. The material of the pipe 102 can have other desired properties such as high thermal conductivity, high thermal strength, flexibility, high structural strength and resistance to corrosion.

In an aspect, the disclosed thermal sheet is quite versatile and can be configured to for use by human beings for medical or therapeutic treatment of human body or for protecting other objects from extreme temperature conditions. Those conversant with art shall appreciate that such an apparatus can have applications in industry as well.

FIG. 2 illustrates an exemplary schematic diagram of the thermal energy reservoir 200 incorporating a pump assembly in accordance with an embodiment of the present disclosure. The thermal energy reservoir box (TER box) 200 can comprise a thermally insulated chamber 202 that can contain a thermal reservoir substance. The insulated chamber 202 can be insulated such a way that there is minimal heat transfer between the thermal reservoir substance and outside atmosphere. In an aspect, capacity of the thermally insulated chamber 202 can depend largely on the size of the thermal sheet 100 along with which the thermally insulated chamber 202 is to be used as also time period for which the object covered by the thermal sheet 100 is to be maintained at desired temperature.

In an embodiment, there can be a pipe 204 routed through the inside of the insulated chamber 202 with two ends 206 of the pipe 204 extended out of the insulated chamber 202. It can also have a pump 208 configured with one end of the pipe 204. The pump 208 can be a peristaltic pump to prevent any leakage on account of mechanical/sealing failure. The dimensions of the pipe 204 can be such that there is maximum heat transfer between the pipe 204 and the thermal reservoir substance kept inside the insulated chamber 202. The material of the pipe 204 can have desired properties such as high thermal conductivity, high thermal strength and resistance to corrosion. The pump 208 can ensure uninterrupted circulation of a fluid through the pipes 204. The pump 208 and the insulated chamber 202 can be housed in an enclosure forming the T.E.R. Box 200. There can be a wire with a plug at its end which can be plugged to mains to meet power requirement to run the pump. In an embodiment the power can also be used to maintain the thermal energy reservoir at a desired temperature.

FIG. 3 illustrates an exemplary schematic diagram of the thermal sheet along with the thermal energy reservoir in accordance with an embodiment of the present disclosure. The thermal sheet 100, the T.E.R. Box 200 and thermally insulated connecting pipes 302 and 304 can together make a complete usable set of the disclosed apparatus. One end of the pipes 302 and 304 can be connected to the ends 206 of the pipes 204 extending out of T.E.R. Box 200 and the other end can be connected to the ends of the pipe 102. Thus the pipes 102, 204, 302 and 304 can form a closed loop of a continuous channel through which thee fluid can be continuously circulated with help of the pump 208. The fluid flowing through the channel of these pipes can have the desired properties such as low viscosity, high specific heat, large latent heat of fusion and vaporization (to avoid the fluid from freezing or boiling inside the pipes).

With reference to FIG 3, if a surface/body has to be maintained at a low temperature, a heat sink can be used as a thermal energy reservoir. Heat sink can be attained by keeping a very cold substance in the insulated chamber 202 of the T.E.R. Box 200. Ice, cold water, dry ice, liquid Nitrogen, liquid Helium are some such examples and a suitable medium can be chosen depending on the requirements such as temperature to be maintained, duration for which such lower temperature is to be maintained to name a few. Alternatively, it is also possible to keep the reservoir substance at a low temperature by electrically operated means.

In an aspect, the rating of the insulation that thermally protects the insulated chamber 202 can depend on the nature and temperature of the substance stored in the insulated chamber 202. The fluid in the pipe 102 can take heat from the body in contact with the sheet. Air trapped in the pores of the sheet can be maintained at a low temperature by the circulation of cold fluid. The trapped air would provide a gradual constant cooling to the body in contact with the sheet. Fluid circulating in the pipes can take heat from the sheet and deliver it to the heat sink.

On the other hand, if an object has to be maintained at a high temperature, a heat source can be used as a thermal energy reservoir and stored in the insulated chamber 202. Heat source can be achieved by keeping a hot substance in the T.E.R. Box 200. The fluid can take heat from the thermal energy reservoir. Hot water, hot coal, an electric kettle (electrical heating) etc. are some such examples and a suitable medium can be chosen depending on the

requirements such as temperature to be maintained, duration for which such higher temperature is to be maintained to name a few. Air trapped in the pores of the sheet can be maintained at a higher temperature. The trapped air would provide a gradual constant heating to the body in contact with the sheet 100. Heat can be collected from the heat source and can be delivered to the body in contact with the thermal sheet 100.

In an aspect, the equipment can be engineered to meet requirements of specific applications such as in a car, in hospital, in bedroom etc. and the parameters that can be engineered are size of the sheet 100, capacity of the T.E.R. Box 200, the medium for heat sink/source depending on the operating conditions which includes temperature to be maintained and duration for which that temperature is to be maintained. In an aspect, ambient temperature/ surrounding temperature can also be an important parameter.

In an aspect, the disclosed equipment can be used for both heating as well as cooling applications simply by changing the thermal reservoir substance kept in the thermally insulated chamber 202. A hot thermal reservoir (heat source) can provide heating effects and a cold thermal reservoir (heat sink) can provide a cooling effect. In another aspect, various aggregates of the equipment can be interchangeable and used without any changes depending on requirement. The same thermal sheet 100 could be connected with different T.E.R. Boxes 200 for different applications. Alternatively different thermal sheets 100 could be connected to the same T.E.R. Box 200. Further the connecting pipes 302 and 304 can of different lengths and flexibilities in accordance with requirement. Thus the disclosed equipment can be economical to maintain as only the damaged part could be repaired or replaced without disturbing the other parts.

In an aspect, both initial and operating costs of the disclosed equipment would be much lower than that of other methods such as heaters and/or air conditioners, and would not pose any danger to health or the environment. It would also save a lot of energy. Thermal sheets can be used as seat covers for cars or can be placed under the bed sheet to give a comfortable sleep. It can also be used as a heating or a cooling pad in various domestic (to maintain an appliance at a desired thermal condition) and industrial applications (to maintain machinery/equipments at a desired thermal condition). It can also be used for many medical purposes like providing a hot/cold pack on a body part. One major benefit of thermal sheet would be that the same equipment could be used for various applications.

VI. ADVANTAGES

The present disclosure provides an apparatus that can be used for both heating and cooling applications to reduce dependence on heaters and air conditioners.

The present disclosure provides an apparatus that can be used for both heating and cooling applications with minimum changes.

The present disclosure provides an apparatus that consumes very less amount of external energy.

The present disclosure provides an apparatus that has capability to keep a surface/body at a required thermal condition (high or low temperature) over a period of time.

The present disclosure provides an apparatus that can be manufactured in different size and shapes, thereby making it versatile in application.

The present disclosure provides an apparatus that is economical to maintain as only the damaged part could be repaired or replaced without disturbing the other parts.

VII. CONCLUSION

Aspects of present disclosure relate to a thermal sheet that has capability to keep a surface/body at a required thermal condition (high or low temperature) for a period of time. In an aspect the disclosed thermal sheet maintains the desired temperature with a very low consumption of external energy and can be manufactured in various shapes, can have thickness nearly same as of a blanket and is easy to wrap around and use. Therefore the disclosed thermal sheet is quite versatile and can be configured to for use by human beings for medical or therapeutic treatment of human body or for protecting other objects from extreme temperature conditions or to attaining and/or maintaining them at desired thermal conditions. Those conversant with art shall appreciate that such an apparatus can have applications in industry as well.

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